Improved Housing Design for Energy

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Abstract

There are two available methods of reducing the energy that goes into the making of buildings; first, the reduction in the amount of material, and second, the selection of the material requiring least energy to perform a certain function. One consequence of our present scale of buildings is a tendency to diminish the awesome and vast dimensions of natural landscape. As the crises of our environment become more inescapable, there are intensified efforts to remove the design of buildings from the limiting demands imposed by our awareness. There is a relationship between the forms of buildings and the controls that produce them. This includes materials, technical knowledge, verbal development, and social patterns. When an ordinate use of any control occurs, exceeding what the end product requires for realization, the quality of that end product suffers as a cultural and artistic manifestation.

Keywords: *Building Form, Building Performance, Life Cycle Cost, Traditional Control, Mechanical Ventilation*

Introduction

We have become culturally preoccupied with fashion, yet we find no increase in the quality of life to validate these assumptions. We see economic, environmental, and ecological deterioration resulting from high energy use. The economic and social problems faced by people in the developing countries are compounded by the move to the cities. This implies a series of energy dependent facilities, water systems, sewerage systems, electricity, food delivery services and transportation. Most of the families who have thronged to the cities there is a sharp increase in their dependence on and consumption of energy. In buildings, it is often more economical for a speculator to tear down an old building than to renovate it.

The form of buildings developed from an effort to speed design and construction, by making as many components as possible typical. For example, the large commercial building has become a typical sealed volume disregarding orientation and dependent on mechanical cooling to compensate for the heat gain on the outside and on the inside from lights and body heat. Moreover, curtain walls in commercial buildings have far poorer performance in resisting heat loss during the winter. Ludwig Mies van der Rohe’s project for an all-glass tall building became an example for a generation of architects. The building became dependent on mechanical cooling. Mechanical ventilation requires that fresh air be constantly introduced into the building through the duct system. The energy to heat or cool the air that replaces air exhausted to the outside can account for from one half to more than two thirds of the building and cooling load. Lower buildings not requiring vertical transportation have greater surface area with attendant increases in heating and cooling loads.

Energy Use from Materials

Materials are major users of energy in their extraction, refining, processing, transportation, and installation. Misuse and overuse of materials to perform specific functions are as unacceptable aesthetically as they are economically. In order, to grip with this problem, we must understand its true extent, the technical and social causes for its present form, the organizational instrumentalities that assist changes in the way organizational instrumentalities that impede or assist changes in the way things are done and consequences of several available courses of action.

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Our structures contain more material than stability and safety require. Concrete is placed to eliminate the stresses throughout their lengths and is placed to eliminate the complexity of framework and steel placement that respond to varying load. Life cycle costing, the projection technique that considers costs through the life of the building, can often demonstrate the speed with which a well-designed, well insulated building can ultimately save money through higher performance. The energy is not only the processing of energy at the point of manufacture, but all the energy required to mine or extract the raw material, to transport it, to refine it, to fabricate it, and to incorporate it in the building.

When an activity requires a separation from the elements, a membrane is placed between the activity and the outdoors. The provision of centrally produced environmental modification was a preoccupation of the Romans, such as furnace, duct and aqueduct. The Romans in building such structures as the Baths of Caracalla or the Baths of Diocletian provided separate spaces in the structure for furnaces and heating water. Early 19th Century people began to expect mechanical systems in their buildings. Some houses were built with all occupied rooms forming a ring around a central fireplace and a central chimney.

Observing the way the systems operate today, the first impression is the vastness and complexity of the apparatus. A fuel is burned to release the heat to the space. In order to release heat to the space, there must be a large space in contact with the air in the space. If the pipe is doubled back and forth to create a greater surface, it will be more effective in heat transfer. This in turn transfers its heat to the air surrounding the pipe. The air at the far end of the space is gathered back into a duct and is returned to the furnace for reheating.

Computer programs have been developed that simulate the performance of a building on an hour to hour basis, using weather data for the area and taking in account the operation of the various systems within the building, the varying heat output of the occupants and the effects of solar impact, as well as shading by neighboring buildings. Such a system,

called a selective energy system, depends on power generated on the site with the rejected heat put to work.

Lighting Level

Lighting levels can identify the ease of visibility. Efficiency in performing visual tasks is in direct proportion to the foot-candle level of diffuse undifferentiated light achieved in the space. Most of us have a vertical vision cut-off of about 45 degrees above the horizon. If the light fixture is beyond this angle there will be no visual discomfort. The question of glare is complicated. Glossy papers increase glare. On the other hand, the same light that is directional and produces glare is the light that is necessary to understand three-dimensional form.

Outdoor light levels may vary from a sky brightness of 3000 or more foot-candles to a light level in the shadow of a tree of 50ft-c and under. The level of illumination inside buildings range from 10ft-c to 30ft-c to 50ft-c depending of the function inside the different spaces in the residential units.

If a space is to be used for drafting, in accordance with standards, overall light levels of 150ft-c is acceptable if the lamps blend in beautifully with the interior color. If the lamps are turned off once in ten hours they will last $14/19^{th}$ times as many hours as they are burning continuously their rated life 13,300 hours. If the lamps (fluorescent) are turned on and off, their rated life is reduced 10,000 hours of use. So, it is better to leave the lamps on rather than turned off and on every 15 minutes.

Impact of Lighting Level on Health

Prolonged exposure to monotonous environment has definitely deleterious effects. The individual's thinking is impaired, his visual perception becomes disturbed, and his brain pattern changes. It is predictable that a work ambiance with different areas identified by different amounts of light, light used to establish a sense of place, and the possibility of visual relief and contrast would provide a more human enjoyable place to spend one's working hours, and reduce incidence of psychosomatic headaches and fatigue, or driving a person out of self-control.

High light levels are disturbing to people with albinism to people with color blindness, and to people with exotropia, (the tendency for one eye to drift laterally out of alignment with the other). High light levels are also bothersome to people with the type of cataract with opacities close to the nodal points of the eye, since the bright light causes the pupil to contract, making the person effectively blind until lowered light levels once again permit the pupil to enlarge. A further group whose vision is impaired in bright light is those with asteroid hyalites, small soap like deposits scattered through the vitreous through the vitreous body of the eye. The brightness illuminates those opacities with very disturbing light-scattering effects.

Low light levels hinder the vision of older people whose pupils become smaller in old age, giving better depth of field but requiring more light. They are also disturbing to

people who dark cannot adapt and to people with other developing forms of cataracts. Inadequate lighting is harmful to the eyes because they cannot find their way into the ophthalmologists' nosology. The levels in shopping areas rapidly rise to the point of visual hysteria.

Once we have determined where and how much light is needed further energy savings can result. While the fluorescent lamp delivers more lumens per watt than a standard filament lamp in situations where a bright concentrated light source required for effective control, in a reflector, for example – the fluorescent is not a satisfactory source. The filament lamp is still the basis for the headlights of a car.

Heating

Any building that is designed to take advantage of the favorable contributions of the sun to the comfort of the building and to restrict the impact of the sun when it is undesirable from a comfort point of view is a solar building. Virtually every primitive or vernacular building has been shaped by these considerations. The problem heat storage in such buildings has been shaped by these considerations. Heat retaining materials were used to store heat from the hot part of the day and release it to the space or to outside during the cooler hours. All of these were passive systems. Of course, some changes in the building were made by the occupants, openings could be manually operated and the retention or dissipation of heat could either be slowed or accelerated. Essentially, it was the configuration of the building, its materials and its openings, and its relation to other buildings that grew around it that determined conditions within the building. There are obvious limitations of this approach that we can meet in one of two ways, or a combination of both. The first is to limit the building itself to spaces that can be served by the natural environmental forces. The second is to capture these forces, convert them into a transportable form, and redirect their impact.

Solar Collectors

Solar collectors are concerned with these latter choices. The solar collectors take advantage of the heat of the sun to warm water. The heated water is conveyed by pipes to a storage medium, a large tank of water and is then recaptured when it is needed and directed to its destination. It is the temperature differential that will be exploited to do work that can vary from heating a space. The more nearly perpendicular the receiving surface is to the rays of the sun, the greater the collecting capability. The simplest type of collector is the flat plate collector which is generally designed to take advantage of the greenhouse effect. The sunrays pass through a sheet of glass, which has higher insulating efficiency, on the way to the collector surface, which is usually a metal panel painted black or dark green to absorb the suns heat. The heat is trapped behind the glass since glass has a high transmission rate in respect to the short-wave energy of solar radiation but a high resistance to the transmission of the long wave energy of heat. This trapped heat is used to heat water, which is in pipes attached to the surface of the plate or in integral waterways formed into the collector plates. In order to prevent heat loss from the back of the collector plate, insulation is added. Various modifications of the

configuration of the plates, the kinds of waterways provided, the liquid used, the method of coupling one plate to another, the kind of paint, and the color that are most efficient.

To achieve high temperature it is by keeping the water in contact with the collector for a longer time. As a rule the solar collector ought to have an area about half as large as the floor area it is serving. If houses are carefully designed in relation to exposure, performance of skin, amount and orientation of outside walls and openings, their requirements for heat introduced into the spaces can be materially reduced. The direct sun-light coming in through southern windows is solar heat, just as truly as the heat captured in the collectors and transferred to another part of the house. If the house has a slab on grade with insulation under it and perimeter insulation around it, the solar heat coming through the south windows will fall on the floor, heat the slab, and be captured and stored there for release when the sun is no longer shining. If the house has thermal shutters that can be closed without escaping through the opening that admitted it.

Flat-plate collectors have become the visual symbol concern for energy and the environment. A collector on the roof collectors with parabolic cross sections and mirrored surfaces can focus the sun's rays on a pipe, but only if they can track the sun and remain in the correct angle with the rays. Moreover, they depend on clear skies since they lose their effectiveness when the point source, the sun is obliterated. Flat plate collectors, on the other hand, will continue to be somewhat effective, even when the sun's energy is diffused by cloudiness. As a result of the complex control problems, these concentrating collectors have been investigated mostly for industrial purposes and power generation. Eric Wormser, has developed a solar collector covered by a flap that hinges downward. The flap has a mirrored inside surface, and when dropped at the appropriate angle, it directs and additional heat to the collector surface, adding this to the heat coming on to it directly. In a simple way the approach is related to the more complex concentrating collectors.

The heat collected by the collectors is transferred to a column of air between the collecting surface and the glass on the outside. The heated air tends to rise by convection and is introduced into the space behind the collector through a slot at the top. Air from the space that has cooled is brought into the collector through a slot in the bottom. It in turn, is heated and a continuous process takes place as long as heat from the sun is applied to the collector. Since there is an immediate response to the presence or absence of solar heat, there must be a conventional back-up system installed as well. The system does have the advantage though of depending of vertical collectors. These collector both direct and diffused heat. The complete façade of a building could be benefiting from this free energy, transferring it as warm air to the inside.

Solar heating offers us a perspective for carrying on our lives without running through our complete legacy of fuels and resources. The development of solar cells for the direct conversion of sunlight to electricity, and the energy of wind will be exploited both in the obvious advantageous response of the building to the air movement resulting from

prevailing breezes and from use of the wind to drive wind-powered generators and pumps.

If one evaluates the difference between electing to build the floor stabs of a building in reinforced concrete rather than structural steel in one year's office building, the saving will be great in oil. The comparisons indicate that a careful study of the materials of building will provide the opportunity for substantial reductions in the energy needed per square meter of building.

Form, Scale and Proportion of Buildings

Changes in the form of building come slowly. There are two routes that are advocated as ways out of the energy crisis. One is a dependence on the technology that has gotten us where we are. The other is a new attitude that relates energy use to the life it supports. These two divergent attitudes express themselves differently at all levels, from the largest scale examination of the problem in its national and international manifestations to the smallest details in its execution, the size of buildings and the kind of openings.

A more careful investigation of needs, an accelerated research program into the use of available resources. If nothing else called for a reexamination of the problems facing architecture, this should. The shape of architecture and the programming of architectural projects come back eventually to the basic question of what mankind's shelter needs are, what means and techniques are available to solve them, and how these interrelate. Formerly, the shape and materials of building were largely local or regional matters, and morphology of shelter accurately reflected the native materials, and the tools developed to work them.

These traditional controls have a more limited applicability today. The growth in population and the incredible burgeoning of the urban centers means that building problems are not susceptible to entirely local and idiosyncratic solutions. The source of materials is world-wide, scarcities, and buildings designed to overcome energy penalize everyone who needs energy for survival. Any architectural critic, architectural instructor, or architect who fails to make the connection and understand their significance may well be heading to an inconsequential future. First studies are being made to determine what is needed to provide adequate housing. How much water, what materials, how much space, what communal facilities, what power systems, and what transportation arrangements?

For many years a dominating aesthetic that shaped our buildings and cities derived from the Renaissance principles stated by Palladio and Alberti, for example, institutionalized in all the formal architectural teaching such as the Ecole-des-Beaux-Arts in France. Sublimating the adaptations of the classic order, there was an overriding concern for proportion as the generator of aesthetics. In both the Renaissance and medieval schools the dimensions of the projects have been determined by a building craft of trained individuals.

Impact on the Landscape

One consequence of our present scale of buildings and mode of travel is a tendency to diminish the awesome and vast dimensions of natural landscape. The building is considered an object that exists by and for itself and humans and their constructions have no interrelationship with the built environment. This thought is damaging and should be avoided instead it becomes apparent that there are ways to build that do not destroy the environment but enhance it and give it a new significance. This problem can be resolved by finding the most ideal proportioning of a space rather than producing a building as an absolute object in space, shaped only by the resolution of the special dynamics being investigated. As the crises of our environment become more inescapable, there are intensified efforts to remove the design of buildings from the limiting demands imposed by our awareness. At the same time unprecedented amounts of heat are being released in our cities partly by the nature of urbanization and by the way in which our cities, change in their ability to recover from unacceptable levels of solar heat accumulation.

There is a point in the enlargement of the size of this heat retaining mass at which the exchange of the day and night air can no longer take place, and there is a resulting change in the quality of the atmosphere of a whole region at the same time that heat is released, the combustion of the various fossil fuels and the chemical additives that are mixed with them release gases into the atmosphere resulting to a serious health consequences. This has resulted in high pollution levels in both Beijing and Delhi, for example. The greenhouse effect of the carbon dioxide that traps heat in the lower layers of the atmosphere, and the reduction of ozone in the stratosphere-all extremely complex large scale phenomena affected by the interaction of one on the rest resulting a pollution extending for several hundred kilometers. The ecological problems resulting from our waste disposal methods and our sewage disposal techniques are damaging our health. So there is an urgent need to relearn the way to build buildings that function simply and without a surrender to energy dependent systems. We must respect the indivisible nature of the earth’s support systems so that we can satisfy people’s needs without destroying their earth.

Conclusion

There is a relationship between the forms of buildings and the controls that produce them. This includes materials, technical knowledge, verbal development, and social patterns. When an ordinate use of any control occurs, exceeding what the end product requires for realization, the quality of that end product suffers as a cultural and artistic manifestation.

The founders of the new architecture stressed the aesthetic elegance of the design solution in which all parts exactly responded to their performance requirements. The resulting loss of architecture’s styles brought with it the characteristic buildings that surround us, functioning poorly and consuming high and unnecessary amounts of energy. Where high performance is a major requirement for an object, its form will be distinctive and elegant.